Using Smart Stormwater Controls to Meet Stormwater Requirements and Preserve the Aesthetic Character of Two Historic Ponds in Harrisburg, PA

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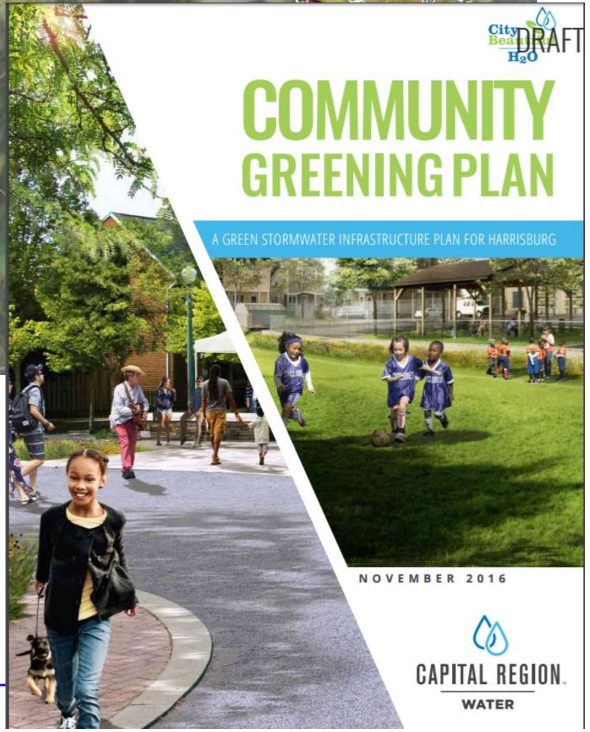
Project Background

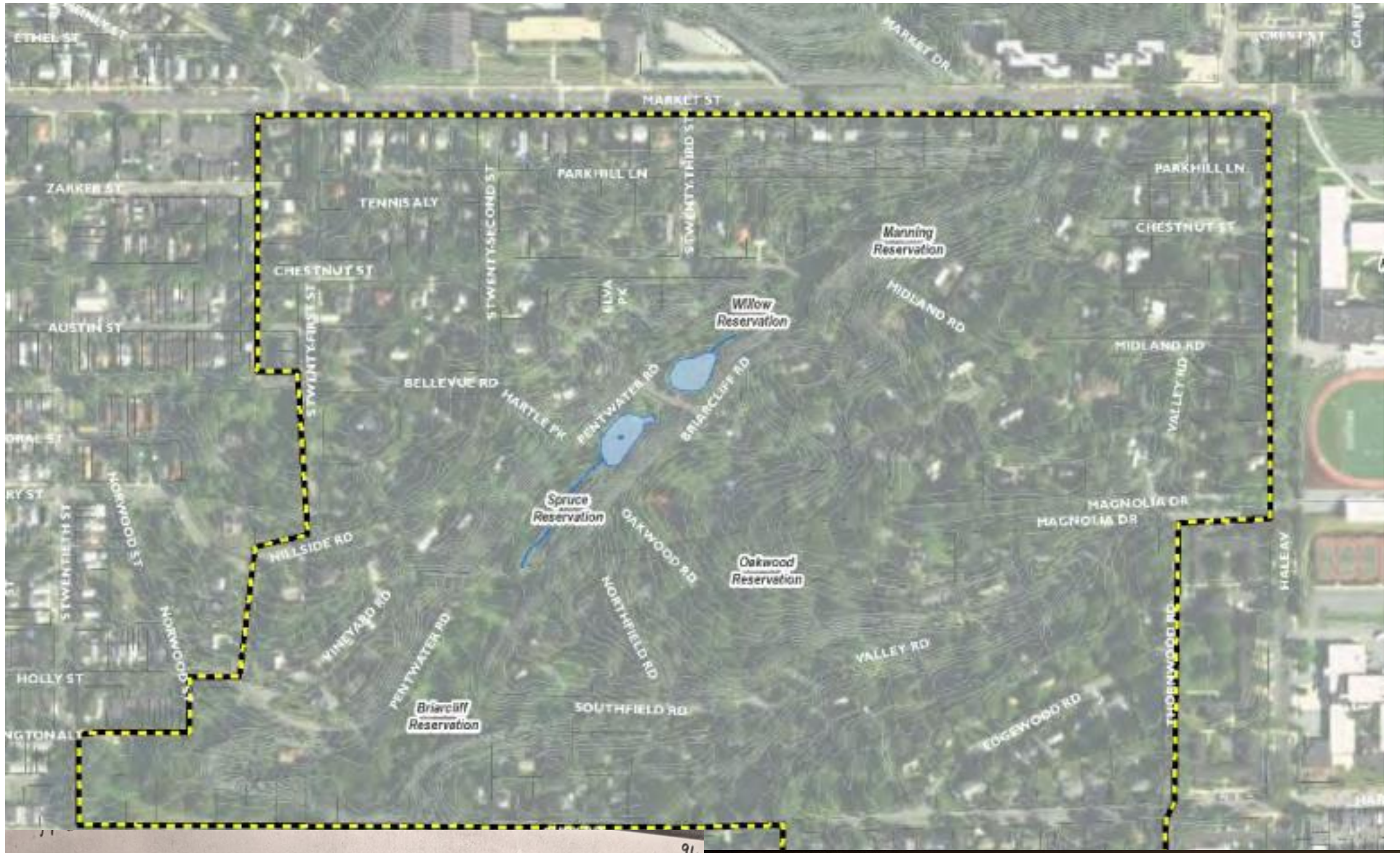
- Pond retrofit project identified in Mish Run Hydrologic Study
- Implemented through CRW's City Beautiful H2O Program Plan to reduce CSO's in Lower Paxton Creek Sewershed
- Located in historically significant neighborhood in Harrisburg, PA
- CRW and Bellevue Park Association (BPA) Partnership



2017	2018	2020-2021	2022-2023
Mish Run Hydrologic Study	City Beautiful H2O Program Plan	Field Work & Detailed Design	Bidding & Construction

Historic Context

- PA’s first planned Residential Community, established in 1910
- Designed by renowned landscape designer, Warren H. Manning
- Over 12 acres of open space, including five common “reservations”
- Two connected man-made ponds for recreation and aesthetics in the Willow and Spruce Reservations
- ***Challenge: Retrofit ponds to meet design goals without altering the historic character of the ponds***



Existing Conditions

- Hydraulically connected man-made ponds
- Primary water source is 42-inch RCP storm sewer (dry weather flow observed)
- Eutrophic, heavily silted, shallow depth
- Pond bank erosion
- Lower Pond spillway erosion due to overtopping
- Water & Sediment sampling results:
  - Low Dissolved Oxygen
  - High Nutrients
  - Metals and other pollutants (VOC’s) detected in sediment

Upper Pond Existing Inflow & Overflow Structures

Lower Pond Existing Spillway Photos

Bellevue Park Pond Retrofit

- CRW goals:
  - Improve pond water quality
  - Optimize the ponds for stormwater management
  - Improve habitat and ecological functions
  - Balance landscape aesthetics & function
- Community goals (in addition to the above):
  - Maintain/enhance historical character of ponds as a neighborhood centerpiece
  - Retain/enhance recreation opportunities

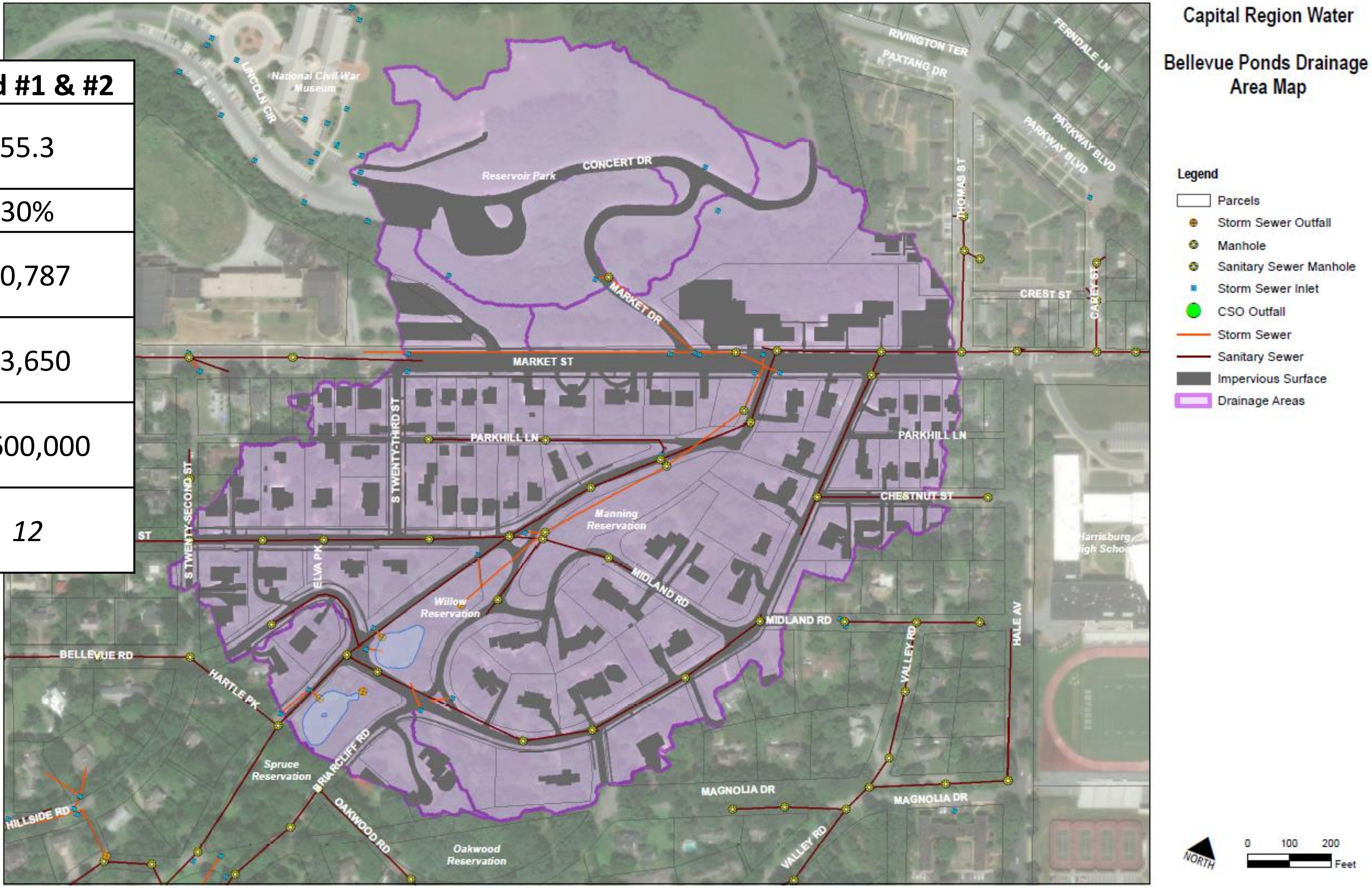
Rendering by LandStudies, Inc.

Additional Design Elements

- Maximize pond storage through bank grading and sediment removal
- Design overflow spillway for peak rate attenuation, stable transition to stream, and safe passage of the 25-year event
- Edge grading and landscaping for habitat and aesthetics
  - Too “wild” or “natural” may be perceived negatively by community
  - Accommodate maintenance access

Bellevue Park Ponds Drainage Area

	Pond #1 & #2
Total Drainage Area (ac)	55.3
Impervious (%)	30%
Minimum Volume Goal (0.85") (CF)	50,787
Optimum Volume Goal (1.4") (CF)	83,650
Typical Year Runoff Volume Inflow (CF)	1,600,000
Typical Year Runoff Volume Inflow (MG)	*12*

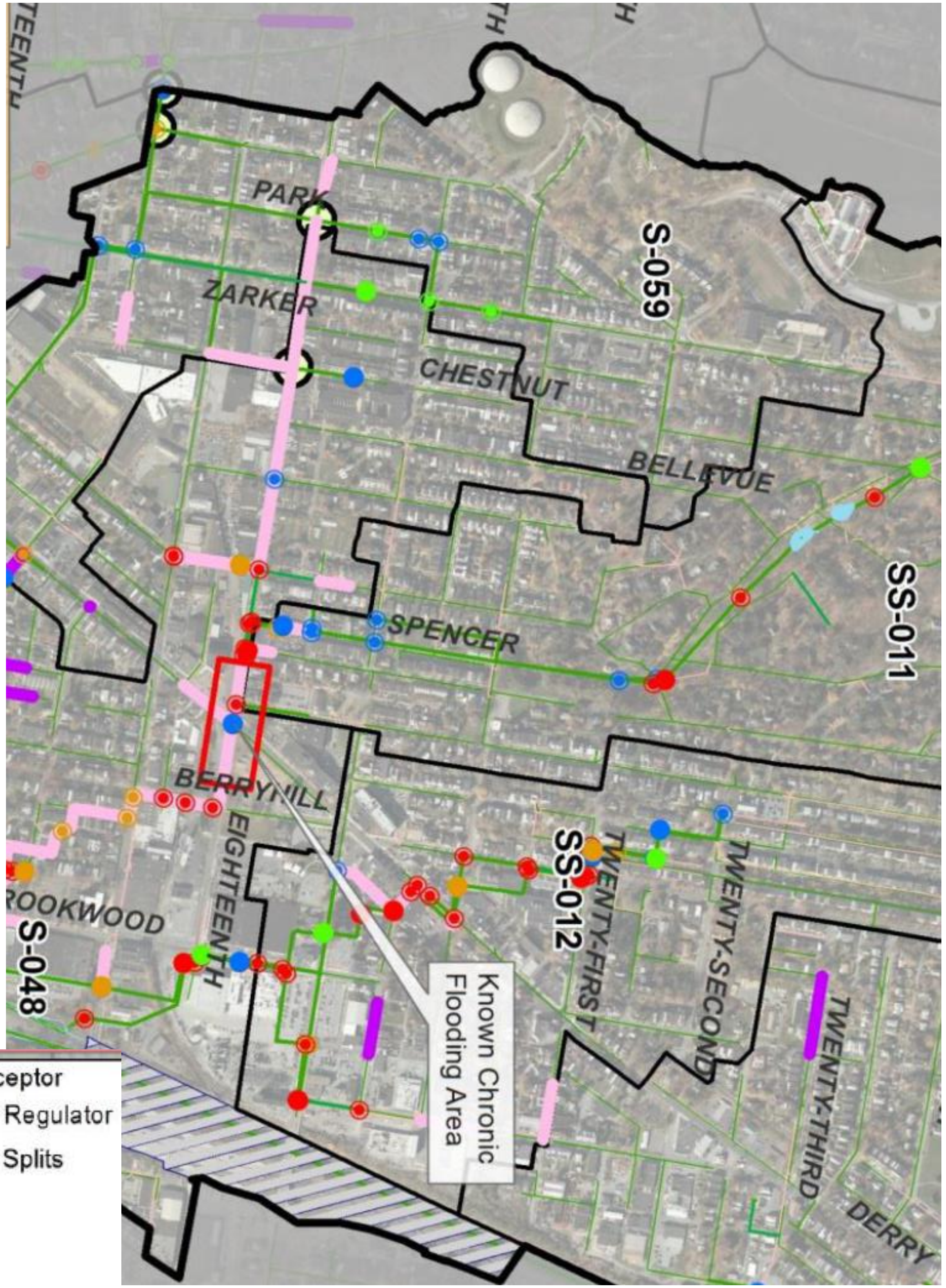


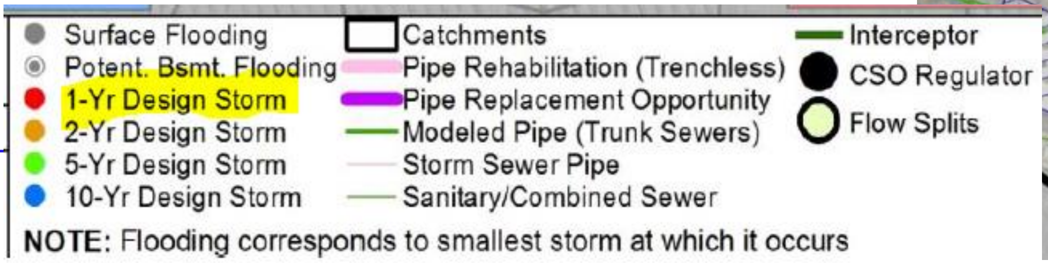
Design Criteria- Volume & Rate Control

- **Volume** – Provide temporary storage of runoff from impervious drainage area

- **Rate** – Design for 1-yr, 24-hr design storm
  - Goal of peak overflow release rate of 0.05 cfs/acre → 0.83 CFS (Impervious DA)
  - Maximum drain down time of 72 hours

- **Flooding** – Potential benefit of reduced flooding at downstream neighborhood





Why Continuous Monitoring and Adaptive Control (CMAC)?

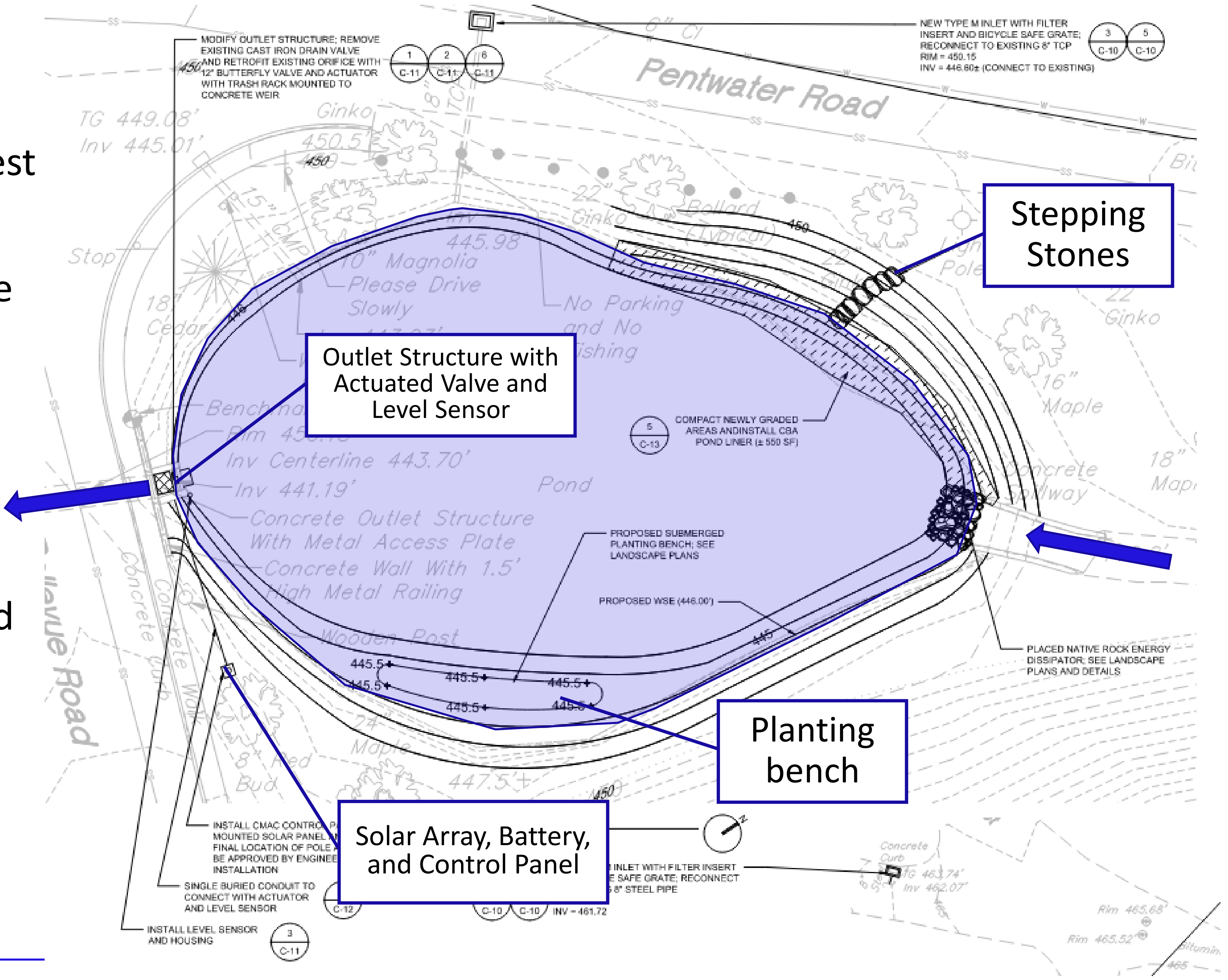
- Community desired a spillway design that mimics the historic spillway
- Design to provide free surface flow through both ponds
- Ponds were originally designed to be landscape features, NOT stormwater ponds
  - Limited existing stormwater storage
  - Limited space to enlarge ponds
  - Lower pond overtops in large storms
  - Engineered “improvements” changed pond character and allow increased stormwater flow through the ponds

Incorporate aesthetics of historic spillway and in cascading channel to stream

Spruce Pond, in "Pentwater Park" Reservation. The trees are

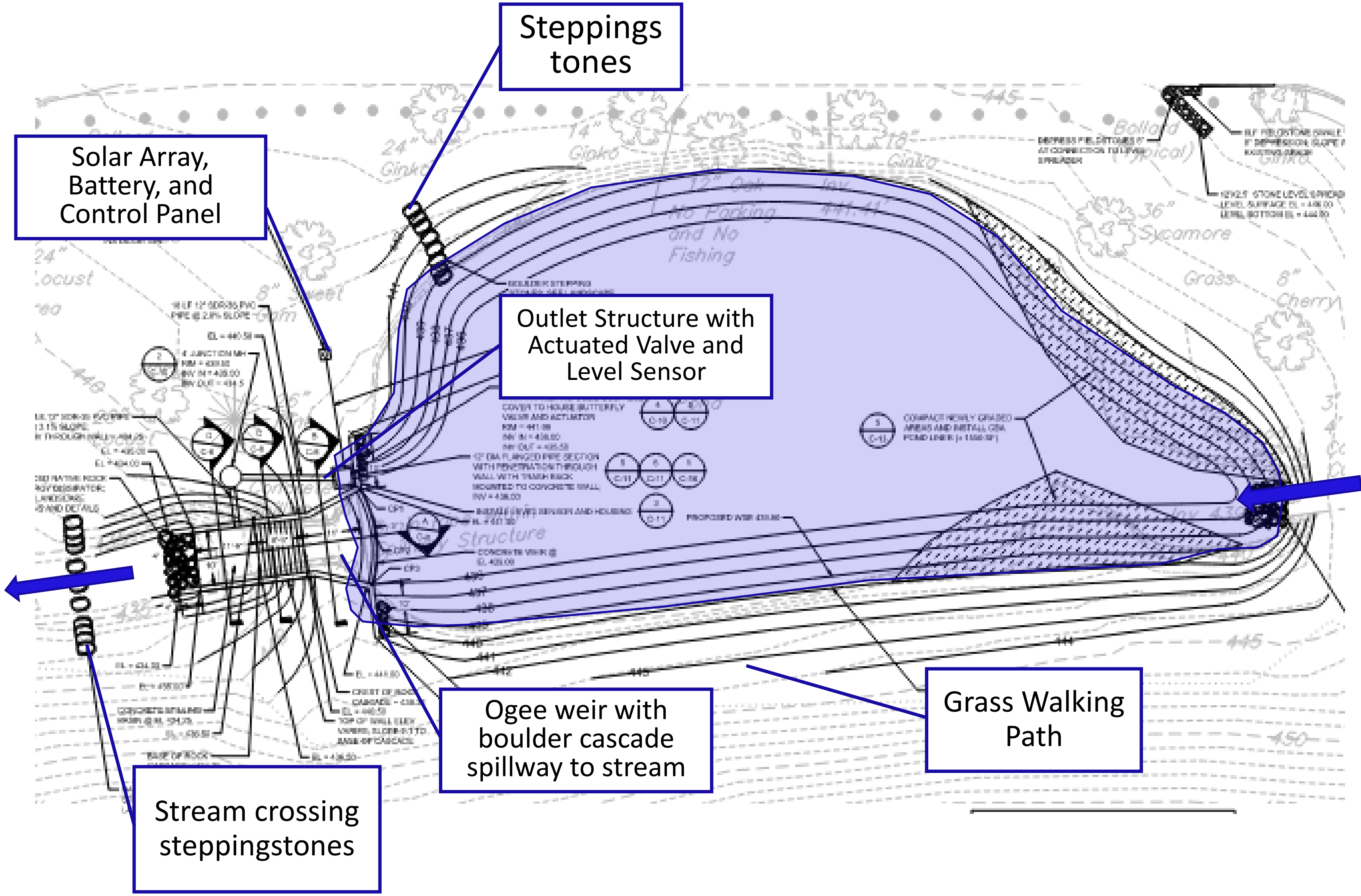
Upper Pond Design

- Submerged planting bench to add interest and diversity to the plant communities
- Rock energy dissipator at the base of the inlet spillway
- Regrading and plantings around the perimeter of the pond
- Boulder steppingstones access point
- Outlet structure modification (controlled low-flow orifice and restoring use of secondary overflow grate)



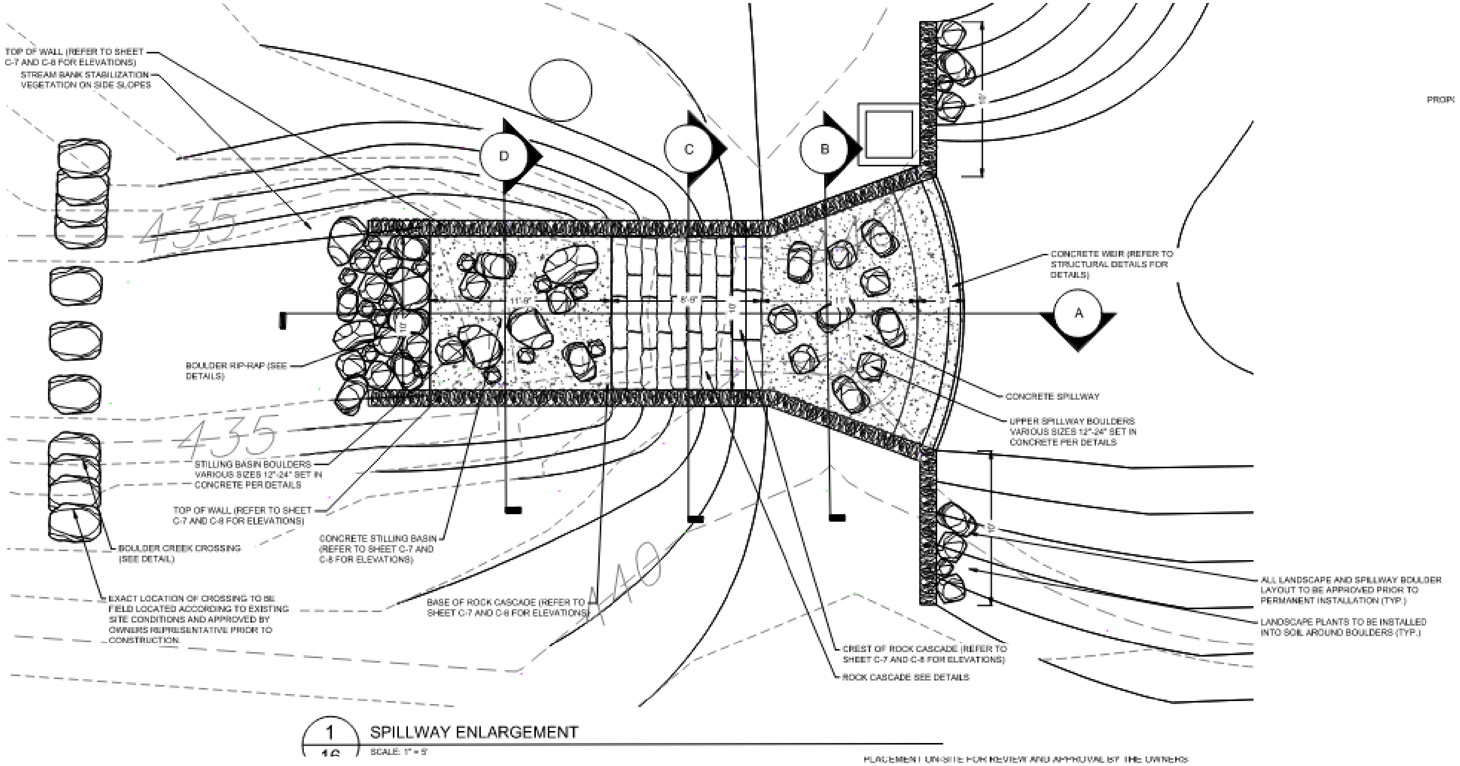
Lower Pond Design

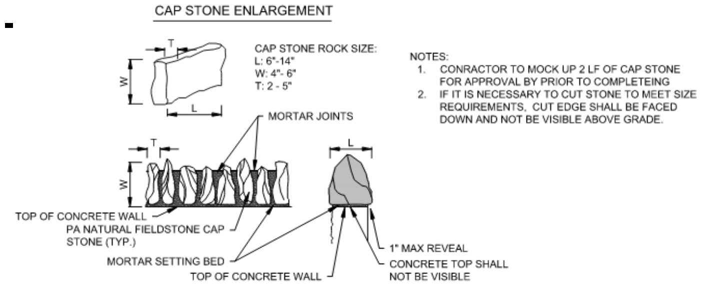
- Grass pathway to be maintained
- Regrading and plantings pond perimeter
- Boulder steppingstone access point
- Outlet spillway reconstruction with concrete ogee weir and “natural” rock spillway cascade and stabilized concrete/rock stilling basin to the existing stream
- New outlet structure with controlled low-flow orifice

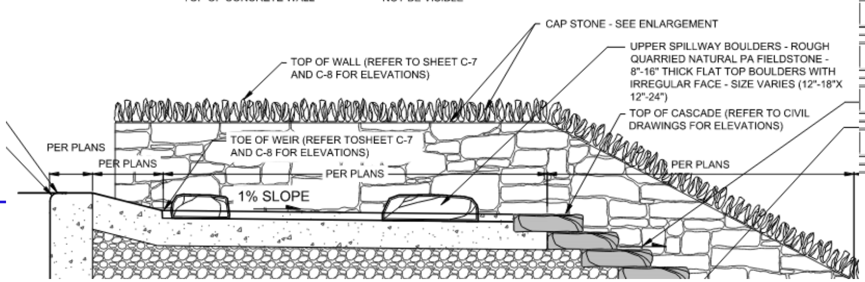


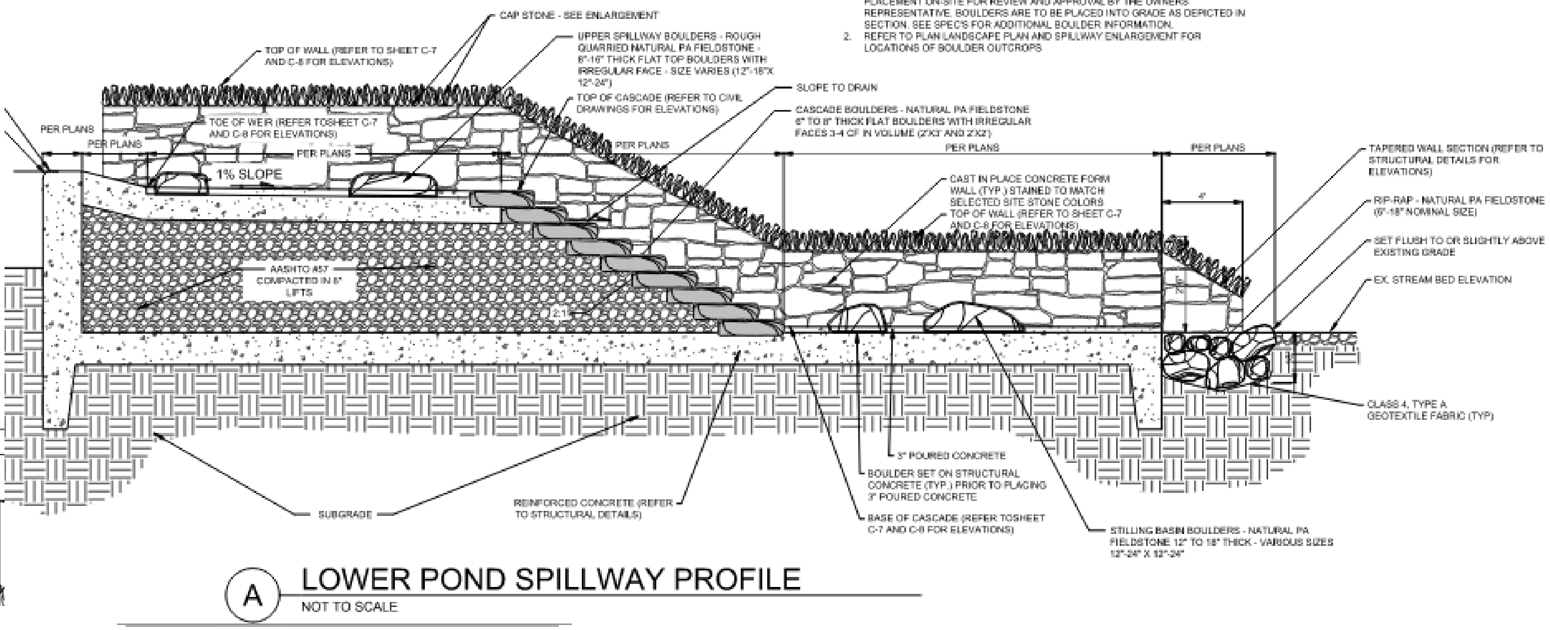
Spillway Design Details

- Concrete walls
- Natural PA field stone
  - Wall cap stone
  - Embedded stones
  - Boulder cascade
  - Energy dissipators
  - Stream crossing







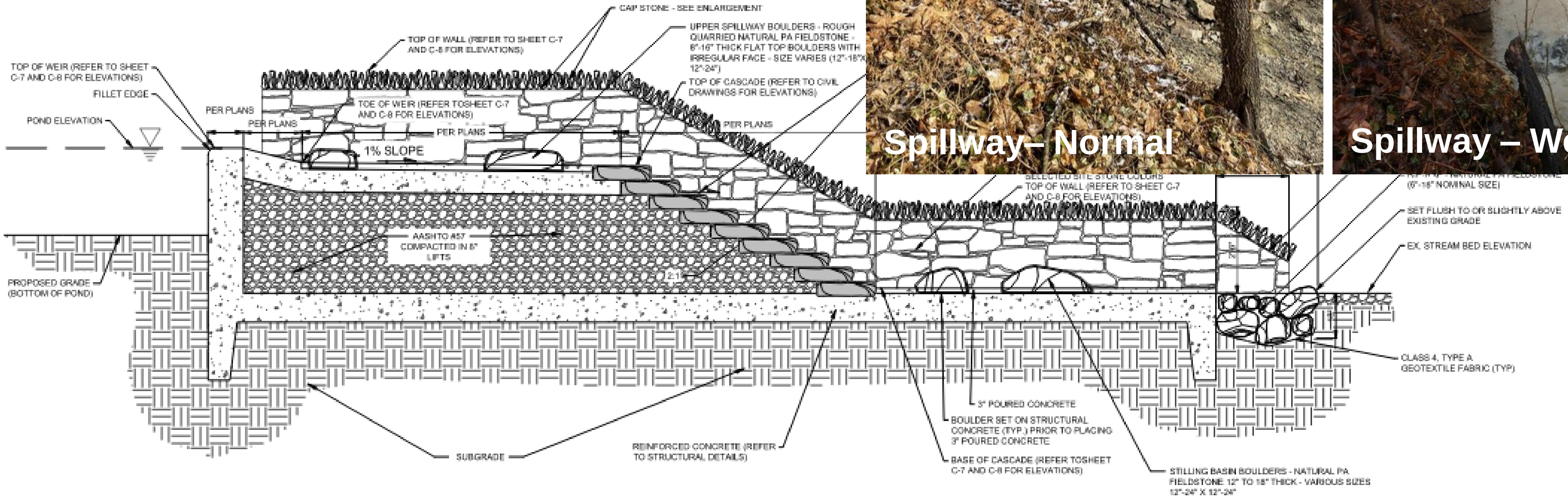


Boulder Cascade Concept

- Natural PA fieldstone
  - 6”-8” thick flat boulders with irregular faces
  - 2’x3’ and 2’x2’ boulders stacked to create stone cascade

Spillway– Normal

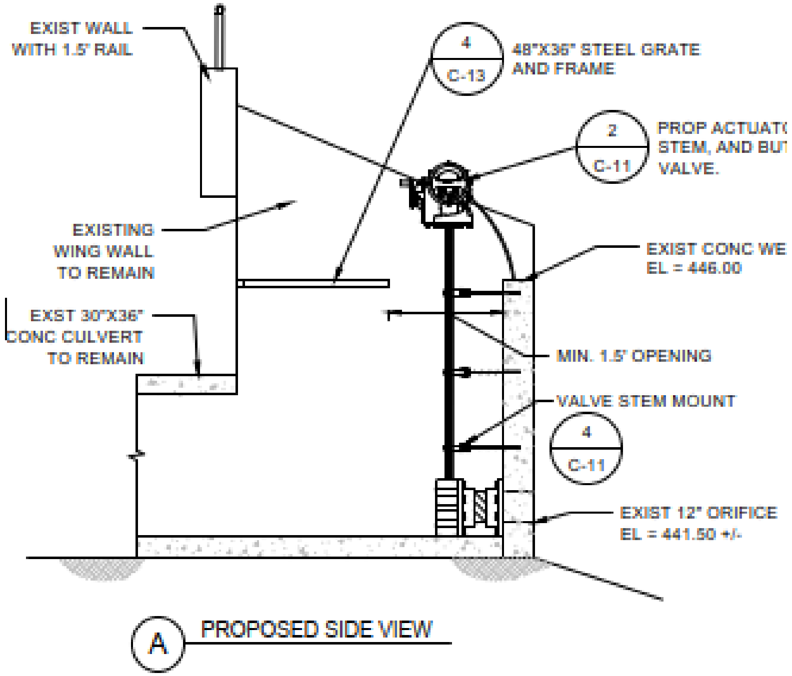
Spillway – Wet Weather

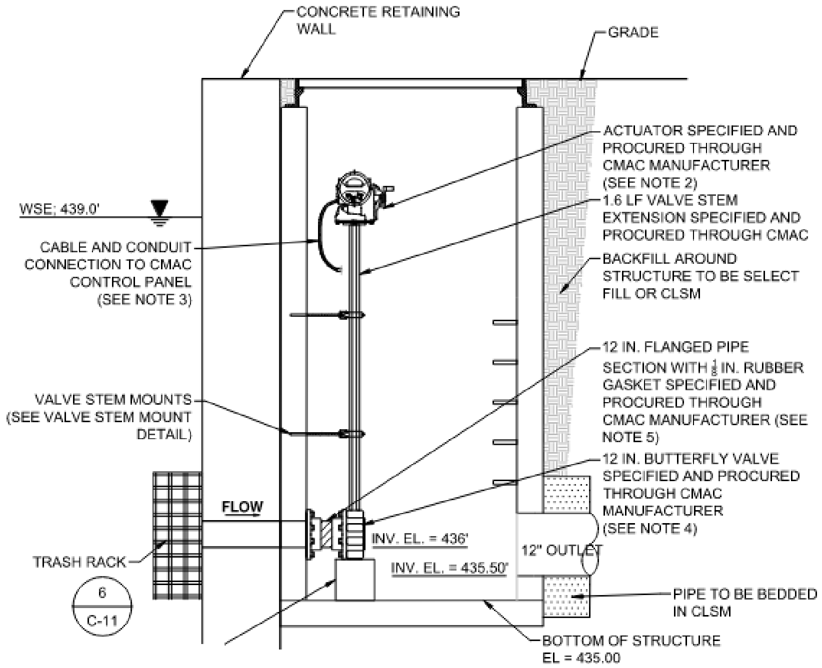


A LOWER POND SPILLWAY PROFILE
NOT TO SCALE

CMAC System Design Upper & Lower Pond

- Water level sensor
- Automated butterfly valve
- Control panel
  - Panel is equipped with a cellular gateway and integrated cellular antenna for communication with the CMAC Software Platform
- Power – Solar Panels





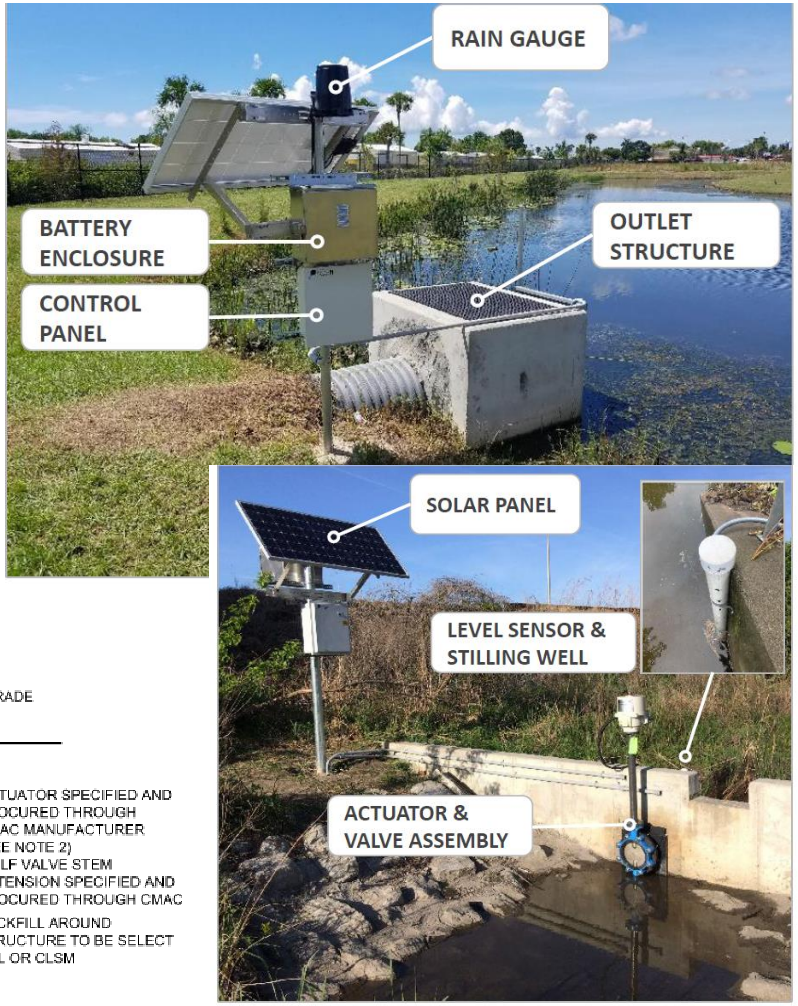


Image Credit: OptiRTC, Inc.

CMAC System Design Modes

Water Evacuation – PRE-STORM

- When rainfall is predicted, CMAC system will open valves to discharge water to the minimum allowable pond water surface elevation (WSE):
  - 2-feet below the normal WSE in each pond
- CMAC system will maintain the maximum allowable flow through the Lower Pond orifice of 0.823 cfs during wet weather.

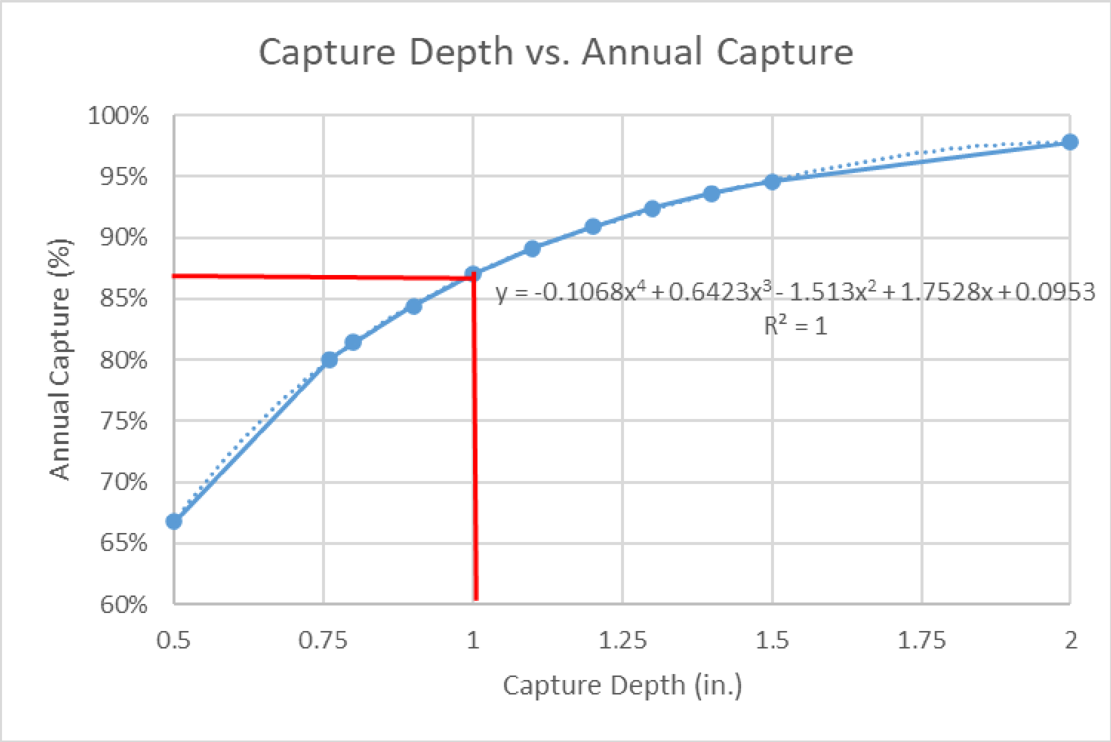
Water Retention - NORMAL

- Valves closed for passive discharge over pond weirs
- Maintain a consistent WSE in the pond, during normal operating conditions, for aesthetic and ecological purposes.

Pond Storage Volume Summary

	Existing Ponds		Proposed Ponds	
Description	Upper Pond	Lower Pond	Upper Pond	Lower Pond
Storage volume bottom elevation	446	439	444	437
Storage volume top elevation (before overtopping)	450	440.2	450	441
Storage Depth (ft)	4.0	1.2	6.0	4.0
Storage Volume (CF)	41,425	12,540	**58,720**	**40,880**
Controllable Storage Volume (volume below normal water surface elevation) (CF)	0	0	15,480	18,290

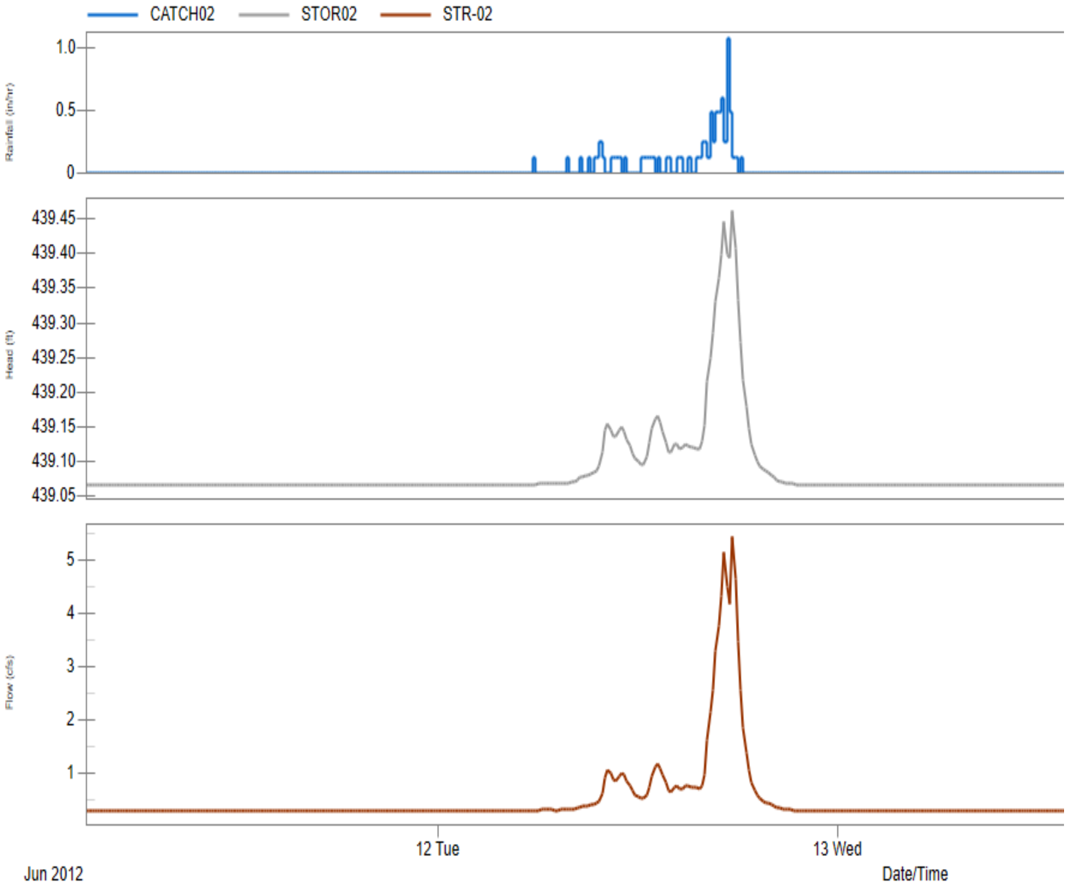
Bellevue Pond Model Results Summary – Typical Year



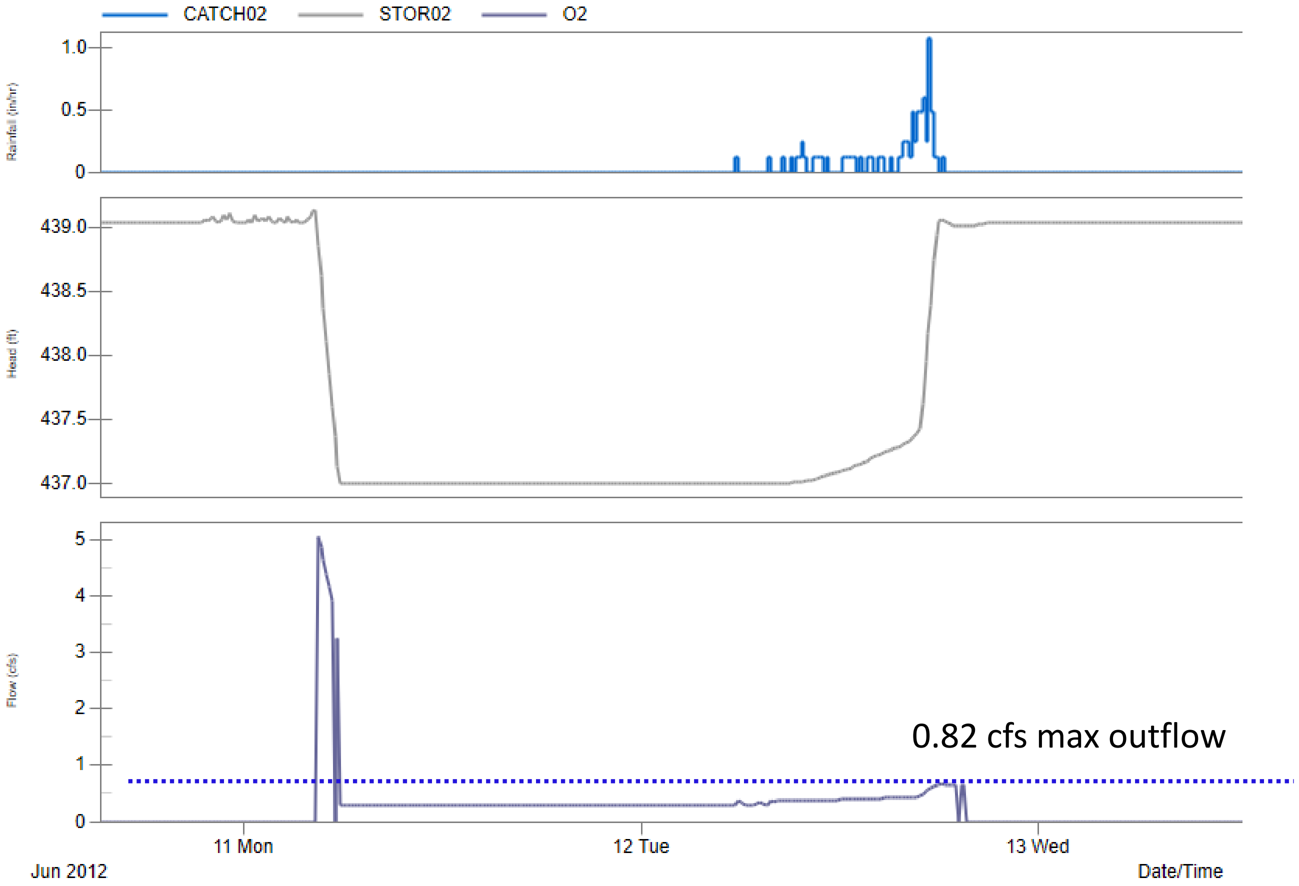
Model Results Summary - Typical Year

	Lower Pond		
Description	Existing	Proposed	% Reduction
Max Wet Weather Flow (cfs)	16.6	24.6	-
Max Dry Weather Flow (cfs)	1.8	8.3	-
Max WSE in Lower Pond (ft)	440.0	439.5	-
Hrs Exceeding Max Release Rate (0.823 cfs) (hrs)	147.7	23.7	84%
Annual Volume of Runoff (cf)	1,588,425	1,583,890	-
Total volume of wet weather outflow (cf)	1,500,026	982,030	35%
Total volume of outflows exceeding Max Release Rate (cf)	1,012,642	117,728	82%
Annual Volume Captured (cf)	88,399	601,859	-
Annual Volume Managed (cf)	487,384	804,302	-
Total Volume of Inflow Captured and Managed (cf)	575,783	1,406,162	-
% of Runoff Captured and Managed (%)	36%	89%	-
Capture and Management Volume (in)	-	~1.0	-
Greened Acres	-	16.6	-

Bellevue Ponds Model Results – Typical Year



Modeled flows with passive outlet control



Modeled flows with CMAC system control

CMAC resulted in a **100% reduction** in wet weather flow above the max. release rate

(1 inch captured off imp. watershed area)

Bellevue Ponds Model Results – Typical Year

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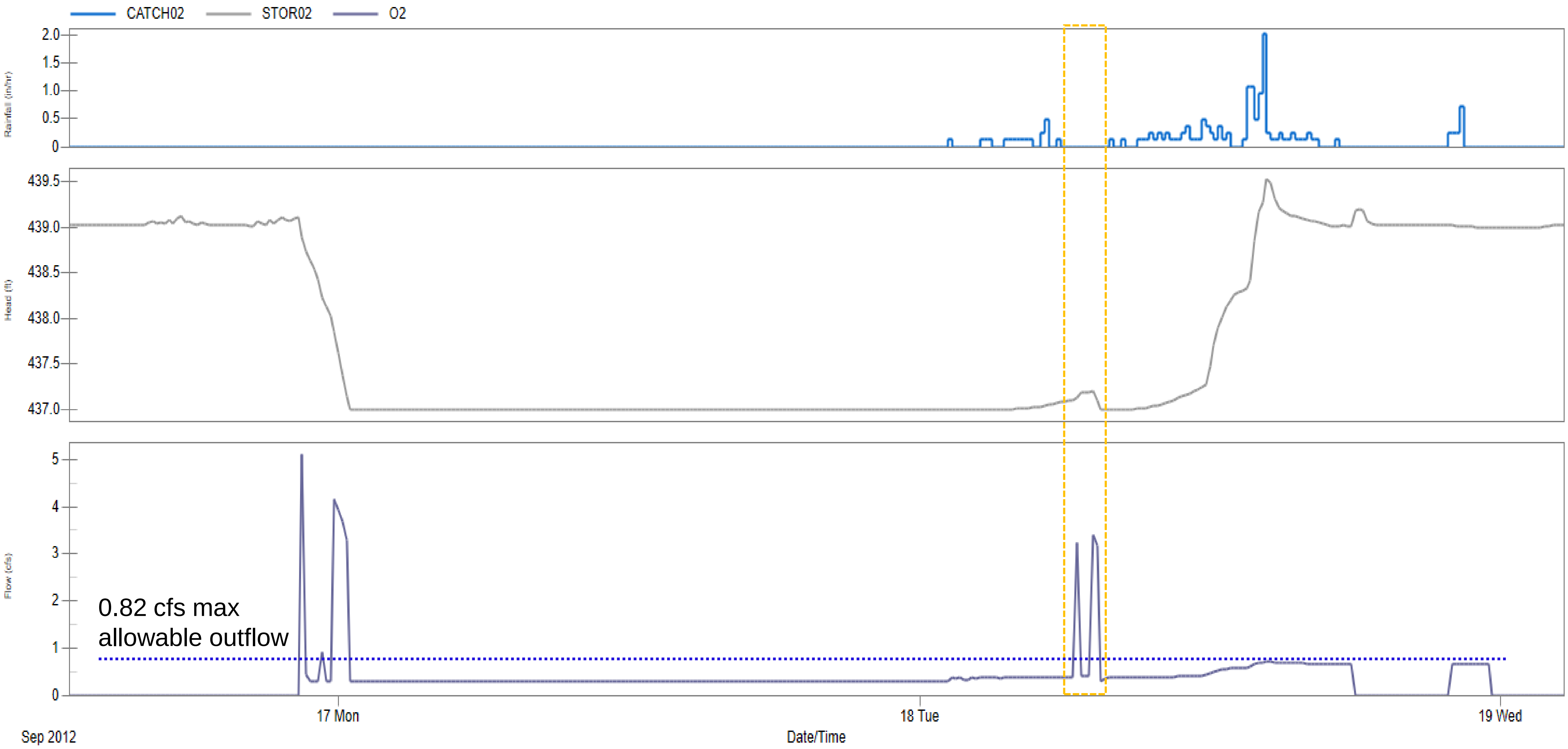

Summary of Benefits

- The system meets and exceeds regulatory retention requirements
- Maintains existing WSE in the ponds and free surficial discharge over pond spillways to maintain historic character of the ponds
- Provides CRW flexibility to control water storage in the ponds based on real time NOAA forecasted precipitation
- Provides CRW flexibility to modify flow discharges from the ponds as needed to adapt to future changes in the watershed

Questions?

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